The Burying Behavior of the Sepiolid Squid *Rossia pacifica*

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Sepiolid squids are known for burying in the sand during daylight hours but little is known of their burying behavior. Many live on subtidal deltas at the mouths of urban rivers so there is the chance of them burying in polluted sediments. Since burying squid are known for their bioturbation of sediments, the burying activity of the stubby squid, *Rossia pacifica*, was examined to determine how it buries, how it breathes while buried, how it sees while buried, and how it behaves under threats while buried. The squid buried themselves using a strict pattern with few deviations, thus indicating the behavior may be a modal action pattern. The squid formed a breathing hole while buried and probably formed a breathing chamber by consolidating substrate grains with mucus, which may be a primary use of its mucus. Under threat, it used water jets to emit “sand geysers” and ink “blobs.” Under repeated threats, it almost always emerged from the substrate, inked, and jetted into the water column. There is strong evidence presented here that *R. pacifica* may use an angling behavior while partially buried.

The Pacific Sand Lance, *Ammodytes hexapterus*, in Puget Sound

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The Pacific sand lance, *Ammodytes*, is a widespread and ecologically important marine forage fish in Puget Sound. In spite of local abundance, little is known of its local biology and life history. Since 1989, WDFW investigators have been able to document the species' widespread use of upper intertidal fine-grained beaches for spawn deposition/incubation. At present, about 140 miles of Puget Sound shoreline have been found to be used by spawning sand lances. Spawning season is November-February. Some features of the sand lance's spawning behavior and spawning substrate grain-size spectra can be characterized. Upper intertidal spawn deposition/incubation makes the sand lance vulnerable to the effects of widespread shoreline armoring. All of its known spawning sites are currently protected by "no net loss" habitat management regulations. The propensity for the species to predictably use certain beaches each year for spawning should allow future investigators to collect important biological data not presently available for local Pacific sand lance populations.

Immunocompetence of Juvenile Chinook Salmon as a Function of Fish Size and Exposure to Dietary Polychlorinated Biphenyls (PCBs)

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Controlled laboratory challenges with *Listonella* (*Vibrio*) *anguillarum* were used to determine the effects of fish size (Study One) and oral exposure to PCBs (Study Two) on the immunocompetence of Puget Sound juvenile chinook salmon. In the first study, three subsets of fish (9, 20, and 39 grams per fish) were randomly allocated to tanks for one week acclimation prior to each challenge. Replicate groups were challenged at three concentrations of Vibrio bacteria (0, 1X, 10X) in either fresh or salt water, and monitored for 14 days. Smoltification status was assessed by monitoring plasma sodium levels prior to each challenge. In the second parallel study, groups of salmon were fed 4 levels of Aroclor 1254 for a period of 4 weeks. Following transfer and acclimation, half of the fish were challenged with Vibrio and monitored for 14 days. Subsequently, the other half was vaccinated (excluding controls) and transferred to challenge tanks. Specific immunity was allowed to develop for 3 weeks prior to Vibrio challenge. Preliminary data indicate fish size may have had a small but significant effect on immunocompetence, but PCB exposure, even at relatively high levels, may not have had a significant effect on growth or survival following challenge.

An Ecophysiological Study of the Effects of Hypoxia and Anoxia on Gelatinous Zooplankton of Southern Puget Sound

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We have examined the oxygen regulatory abilities and ability to tolerate anoxic conditions of several species of gelatinous zooplankton in the southern Puget Sound in order to estimate the effects of low oxygen on these ecologically important zooplankters. We have measured mean oxygen consumption rate, minimum oxygen partial pressure to which the organism can regulate O2 consumption (Pc) and the ability of each species to withstand anoxia. Our study includes ctenophores, scyphomedusae, hyromedusae, and siphonophores. It has been found that several species can oxyregulate at less than 15 percent oxygen saturation, as well as survive at 0 percent oxygen for several hours. The mean respiration rates for the scyphomedusa *Aurelia labiata*, the hydromedusa *Aequorea victoria*, and the ctenophore *Pleurobrachia bachei* were 0.18, 0.31, and 0.13 mmoles O2 g h-1, respectively. Additionally, *A. labiata*, *A victoria*, and *P. bachei* were able to regulate oxygen consumption below 10 percent saturation. These results indicate that gelatinous organisms are better at tolerating poor oxgyen conditions than many of their pelagic competitors and prey.

The Determination of Distinct Population Segments and Risk of Extinction for Puget Sound Populations of Pacific Herring and Brown, Quillback and Copper Rockfish through the Biological Review Team Process

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In response to a petition to list 18 species of marine fish in Puget Sound under the Endangered Species Act, the National Marine Fisheries Service initiated status reviews of seven of these species: Pacific hake, *Merluccius productus* (Ayres, 1855); Pacific cod, *Gadus macrocephalus* (Tilesius, 1810); walleye pollock, *Theragra chalcogramma* (Pallas, 1815); Pacific herring, *Clupea pallasi* (Valenciennes, 1847); brown rockfish, *Sebastes auriculatus* (Girard, 1854); copper rockfish, *S. caurinus* (Richardson, 1845); and quillback rockfish, *S. maliger* (Jordan and Gilbert, 1880). The National Marine Fisheries Service (NMFS) formed three Biological Review Teams (BRT), one for Pacific cod, walleye pollock and Pacific hake; another for copper, quillback and brown rockfish and the last for Pacific herring. These BRTs were composed of scientists with expertise in one or more of these species, to conduct these status reviews. This poster concerns the Copper, Quillback and Brown Rockfish and Pacific Herring Status Reviews that were recently completed. After considering available information on genetics, phylogeny and life history and environmental features that may promote reproductive isolation and local adaptation for these species, the rockfish BRT identified a "Puget Sound proper" Distinct Population Segment (DPS) for each of the three rockfish species. Other DPSs of each of the three rockfish may exist, however, it is not possible to define them given the available information. The Pacific Herring BRT identified a DPS that includes Puget Sound herring populations as part of the larger Georgia Basin DPS.

Various risk factors were identified for each DPS for the three rockfish species as well as Pacific herring. Major causes of risk include overharvesting, predation, regime shifts in the climate, habitat loss or degradation, and effects of pollution.

Conclusions of the biological status reviews have been reviewed by co-management agencies and have been transmitted to the NMFS Northwest Regional Office. Regional Office staff are preparing draft documents evaluating conservation measures and factors for decline. Final determination regarding possible listing proposals are pending.

Visual Development in Pacific Sand Lance (*Ammodytes hexapterus)*

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For fish, the ability to successfully forage and avoid predators is dependent on visual abilities, particularly in the early life history stages. This study examined visual development in Pacific sand lance (*Ammodytes hexapterus*). Visual acuity, necessary for detecting prey at a distance, was measured by determining retinal cone density in fish 17 to 108 mm in length. Improvements in visual acuity were not rapid, indicating that highly acute vision is not a driving selective force in the feeding success and survival of the larvae. Spectral sensitivity, necessary for contrast perception, was measured using microspectrophotometry. Changes in spectral sensitivity indicated that early larvae, which typically inhabit surface waters, are sensitive to blue, green, and violet light. Juvenile and adult fish, which have undergone a habitat shift to deeper waters, have lost sensitivity to violet light. By matching sensitivity to wavelengths commonly encountered in their

photic environment, these fish experience improved contrast perception, facilitating detection of prey as well as predators. Sand lance are an abundant and, for many species, preferred forage fish in Puget Sound. Changes in their photic environment could lead to population declines, which would be felt throughout the food web.